PROTONS TEST REPORT

ESA study: “Survey of Critical Components for 150 kRad Power Systems”

ESTEC Contract N° 22831/09/NL/AF refers

Part Type : OLH7000

Package : CERDIP-8

Description : Linear Optocoupler

Manufacturer: Isolink Inc.

Date Code: 0721

Alter Technology Group Spain Purchase Order N° ATGSP-TL-09-JC-CO-9 dated 11/27/2009

Alter Technology Group Spain Project Manager: David NUNEZ

Hirex reference :	HRX/TID/0883	Issue : 01	Date :	June 7th, 2011
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CHANGE RECORD

ISSUE	DATE	PAGE	DESCRIPTION OF CHANGES
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PROTONS TEST REPORT
on
OLH7000
Linear Optocoupler

From Isolink Inc.

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1 Introduction

In the scope of the ESA study: “Survey of Critical Components for 150 kRad Power Systems”, a protons test of the Isolink Inc. OLH7000, Linear Optocoupler has been performed up to a total fluence of about 2E11 p/cm^2, in response to Alter Technology Group Spain purchase order reference ATGSP-TL-09-JC-CO-9 that refers to ESTEC contract N° 22831/09/NL/AF.

Displacement damage effects were investigated using 60 MeV protons energy. Devices were irradiated at UCL in Louvain - Belgium.

The purpose of this test was to characterize degradation due to proton displacement damage so a further mission analysis could determine their suitability for flight use. This test was conducted on samples provided by Alter Technology Group Spain.
Test has been performed in accordance with Hirex Engineering Radiation Test Plan HRX/SPE/0240 issue 3 dated 09/24/2010.

A complete set of electrical measurements together with graphical representation of measured parameters with respect to Equivalent Fluence levels received is provided.

2 Applicable and Reference Documents

2.1 Applicable Documents

- Hirex Engineering Radiation Test Plan: HRX/SPE/0240 issue 3 dated 09/24/2010
- Alter Technology Group Proposal: ATGSP-OF-648/2009 Issue 1
- Minutes of Meeting: MM-SRP-ATG-0001 dated 29/10/2009
- Hirex specification: Total Ionizing dose test general procedure.

2.2 Reference Documents

- Isolink Inc. datasheet

3 Test Samples

7 samples of the OLH7000 devices were tested (6 + 1 control sample).
Allocation of samples used for testing is provided in the following table.

Number serialized by Hirex	Samples Allocation
111	Control sample
112	Biased OFF
113	Biased OFF
114	Biased OFF
115	Biased OFF
116	Biased OFF
117	Biased OFF

Identification of the OLH7000 is given below:

Part Number: OLH7000

Top Marking: ISOLINK OLH7000-0011 delta 0721

Bottom Marking: -

Date Code: 0721

4 Experimental Conditions

4.1 Radiation Source Description

The protons exposures were performed at the UCL facility in Louvain-la-Neuve - Belgium.
The Proton Irradiation facility (Light Ion irradiation Facility or LIF) was used for this experiment. The corresponding experimental set-up is shown in Figure 1.

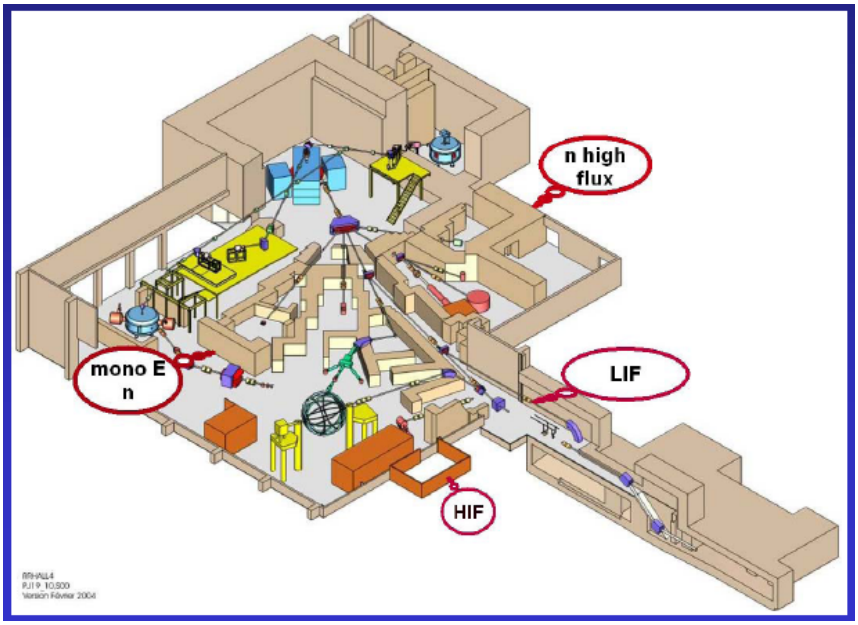


Figure 1 : LIF layout and typical experimental set-up

Light Ion irradiation Facility is characterized by the following beam parameters:
• Initial Proton Energies: 65 MeV;
• Energy Range: 9.3 – 62 MeV using energy degraders (See figure 2)
• Beam Flux at 62 MeV is between 10p/cm2/sec to 5E8 p/cm2/sec
• Irradiation Area: 8 cm diameter maximum

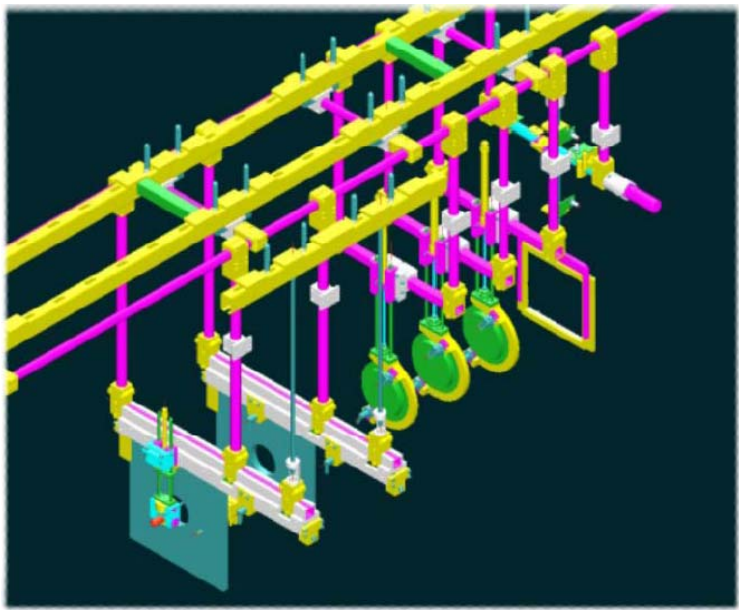


Figure 2: LIF Energy degraders

The irradiation conditions used for this test are provided in the following tables:

Fluence Steps	Total Fluence	Flux	Equivalent Total Dose	T
p/cm² @60MeV	p/cm² @60MeV	p/cm²/s	Rad (Si)	°C
0	0		0	
2E+11	2E+11	5.00E+08	27.5E+3	25

4.2 Bias during Dose Exposures and Measurements conditions

4.2.1 Bias conditions

During exposures all samples were biased OFF with all pins connected to ground.

4.2.2 Electrical Measurements

Electrical parameters test program principle for OLH7000 is provided in Figure 3.

A HP4142 DC tester was used to perform required measurements.

A dedicated test fixture and a test board were designed to ensure proper measurement conditions.

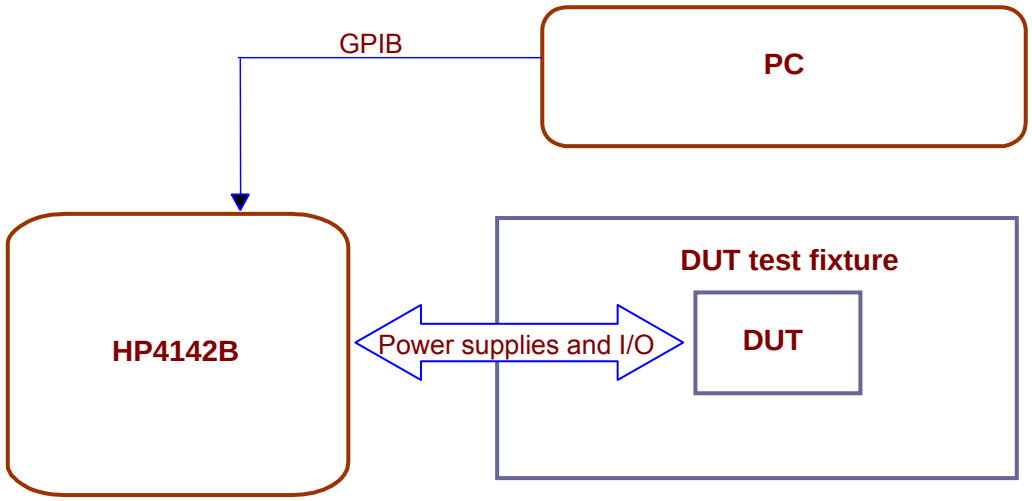


Figure 3 : OLH7000 test program principle

Electrical parameters test conditions and limits used for performing this test are given in Table 1.

Parameters	Description	Conditions	Spec			Unit
			Min	Typ	Max	
VF	Forward Voltage	IF = 10 mA	-	2.5	3.3	V
VR	Reverse Voltage	IR = 100µA	5	-	-	V
ID	Dark Current	VR = 15 V, IF = 0 mA	-	1	25	nA
VOC	Open Circuit Voltage	IF = 10 mA	-	0.5	-	V
K1	Servo Current Gain (IP1/IF)	IF = 10 mA Vdet = -15 V	0.0035	0.0050	0.0065	-
IP1	Servo Current	IF = 10 mA Vdet = -15 V	-	50	-	µA
K2	Forward Current Gain (IP2/IF)	IF = 10 mA Vdet = -15 V	0.0035	0.0050	0.0065	-
IP2	Forward Current	IF = 10 mA Vdet = -15 V	-	50	-	µA
K3	Transfer Gain (K2/K1)	IF = 10 mA Vdet = -15 V	0.75	1	1.25	-

Table 1 : Measured electrical parameters

5 Conclusion

A proton displacement damage test was carried out by Hirex Engineering under Alter Technology Group Spain contract on the Isolink Inc. OLH7000 Linear Optocoupler in CERDIP-8 package.

Each device was exposed at room temperature to a protons flux of 60 MeV incident energy up to a total fluence of 2E+11p/cm².

Forward Current Gain parameters K1 and K2 were found above maximum specification limits specified at initial measurements step. After exposures, K1 and K2 were still greater than minimum specified values.

All other parameters remained within specification limits all along testing.

6 Test Results

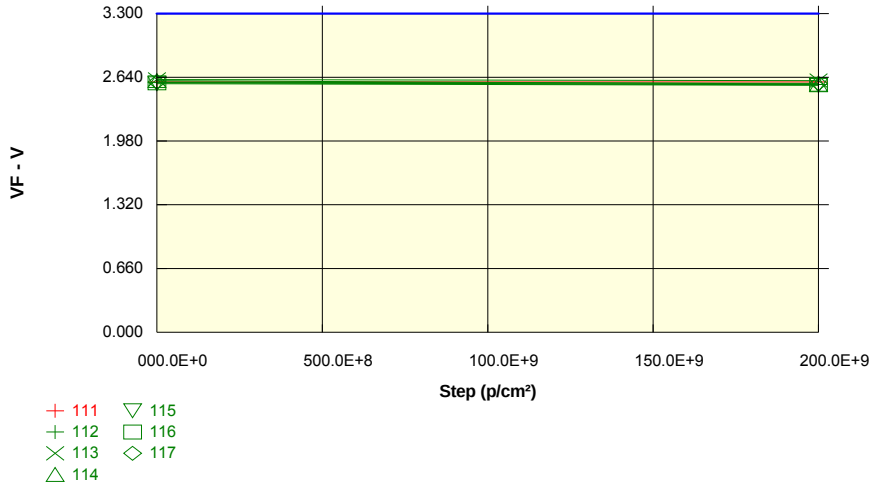
Test results including tables and graphics are provided in this section for each measured parameter.

Parameter measurements values are plotted versus Equivalent Fluence levels for 60 MeV incident energy protons. Fluences are expressed in protons/cm^2 in Silicon.

For each parameter, a drift calculation table is provided computing the drift between a given exposure step with respect to initial readings:

$$\Delta\text{(Parameter value)}=\text{(Parameter value}_{\text{POSTRAD}}\text{)} - \text{(Parameter value}_{\text{PRERAD}}\text{)}$$

Test conditions : Protons
Parameter : Forward Voltage : VF
IF = 10 mA
Unit : V
Spec Limit Max : 3.300
Spec limits are represented in bold lines on the graphic.



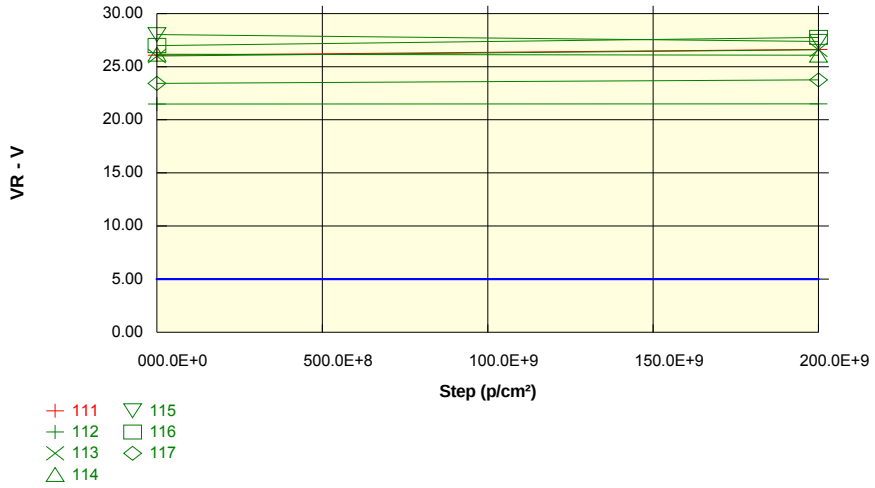
Measurements

VF	0 p/cm²	2E+11 p/cm²
111_REF	2.592	2.592
OFF samples		
112	2.586	2.567
113	2.617	2.606
114	2.606	2.569
115	2.574	2.556
116	2.583	2.562
117	2.592	2.577
Statistics		
Min	2.574	2.556
Max	2.617	2.606
Average	2.593	2.573
Sigma	0.015	0.016

Drift Calculation

VF	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-18.80E-03
113	-	-10.80E-03
114	-	-37.20E-03
115	-	-17.60E-03
116	-	-20.40E-03
117	-	-14.80E-03
Average	-	-19.93E-03
Sigma	-	8.32E-03

Test conditions : Protons
Parameter : Reverse Voltage : VR
IR = 100µA
Unit : V
Spec Limit Min : 5.00
Spec limits are represented in bold lines on the graphic.



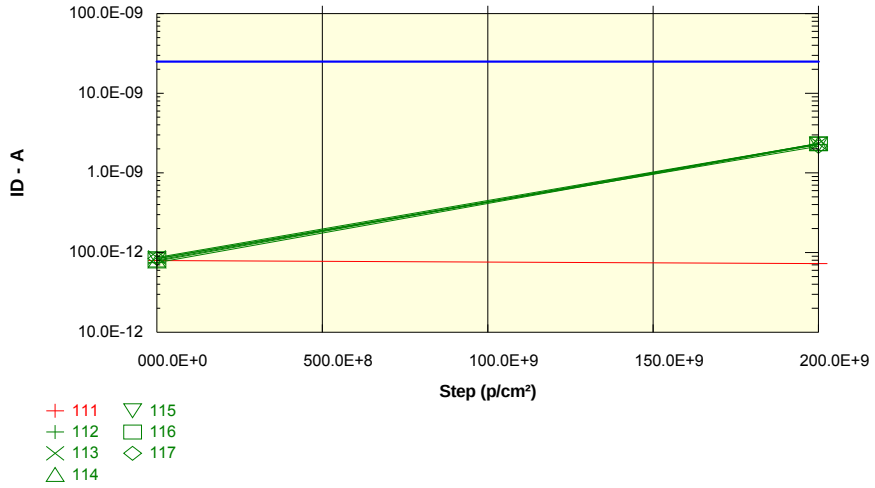
Measurements

VR	0 p/cm²	2E+11 p/cm²
111_REF	26.08	26.63
OFF samples		
112	21.49	21.50
113	26.01	26.59
114	26.17	26.09
115	28.01	27.39
116	26.99	27.76
117	23.42	23.76
Statistics		
Min	21.49	21.50
Max	28.01	27.76
Average	25.35	25.51
Sigma	2.22	2.21

Drift Calculation

VR	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	10.40E-03
113	-	582.40E-03
114	-	-80.80E-03
115	-	-628.00E-03
116	-	761.60E-03
117	-	332.00E-03
Average	-	162.93E-03
Sigma	-	460.29E-03

Test conditions : Protons
Parameter : Dark Current : IDFB
VR = 15 V. IF = 0 mA
Unit : A
Spec Limit Max : 25.0E-09
Spec limits are represented in bold lines on the graphic.



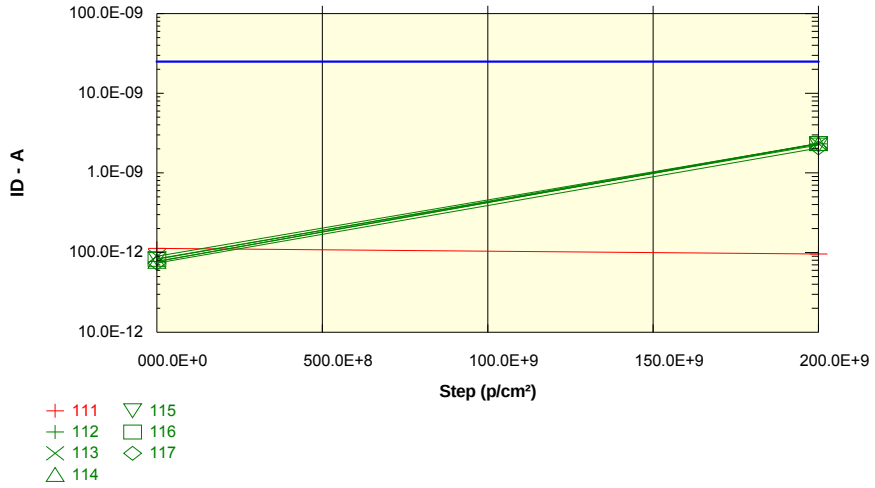
Measurements

IDFB	0 p/cm²	2E+11 p/cm²
111_REF	79.3E-12	72.7E-12
OFF samples		
112	74.9E-12	2.3E-09
113	86.7E-12	2.3E-09
114	78.2E-12	2.3E-09
115	83.7E-12	2.3E-09
116	80.7E-12	2.3E-09
117	84.3E-12	2.2E-09
Statistics		
Min	74.9E-12	2.2E-09
Max	86.7E-12	2.3E-09
Average	81.4E-12	2.3E-09
Sigma	4.0E-12	61.4E-12

Drift Calculation

IDFB	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	2.21E-09
113	-	2.25E-09
114	-	2.26E-09
115	-	2.19E-09
116	-	2.24E-09
117	-	2.08E-09
Average	-	2.21E-09
Sigma	-	62.30E-12

Test conditions : Protons
Parameter : Dark Current : IDFF
VR = 15 V. IF = 0 mA
Unit : A
Spec Limit Max : 25.0E-09
Spec limits are represented in bold lines on the graphic.



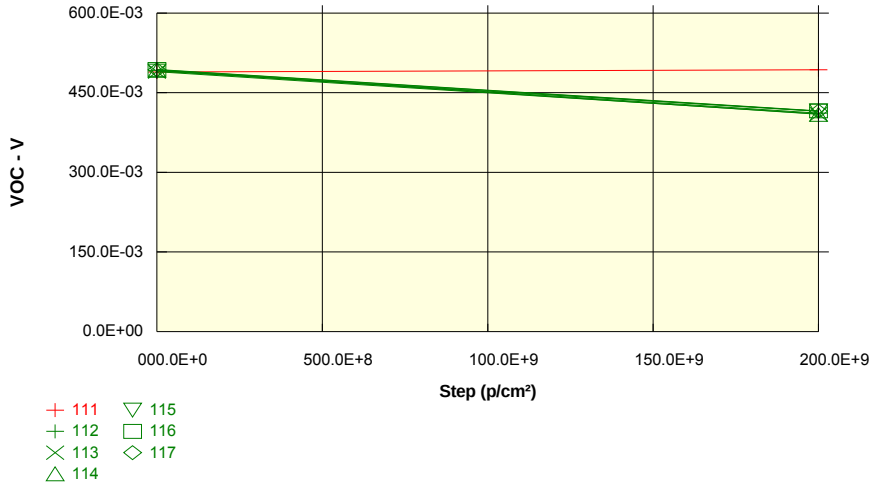
Measurements

IDFF	0 p/cm²	2E+11 p/cm²
111_REF	113.0E-12	95.9E-12
OFF samples		
112	77.3E-12	2.3E-09
113	90.0E-12	2.3E-09
114	77.6E-12	2.3E-09
115	83.5E-12	2.2E-09
116	82.3E-12	2.3E-09
117	73.7E-12	2.1E-09
Statistics		
Min	73.7E-12	2.1E-09
Max	90.0E-12	2.3E-09
Average	80.7E-12	2.3E-09
Sigma	5.3E-12	101.7E-12

Drift Calculation

IDFF	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	2.23E-09
113	-	2.23E-09
114	-	2.26E-09
115	-	2.15E-09
116	-	2.26E-09
117	-	1.98E-09
Average	-	2.18E-09
Sigma	-	99.01E-12

Test conditions : Protons
Parameter : Open Circuit Voltage : VOCFB
IF = 10 mA
Unit : V
No spec limit specified.



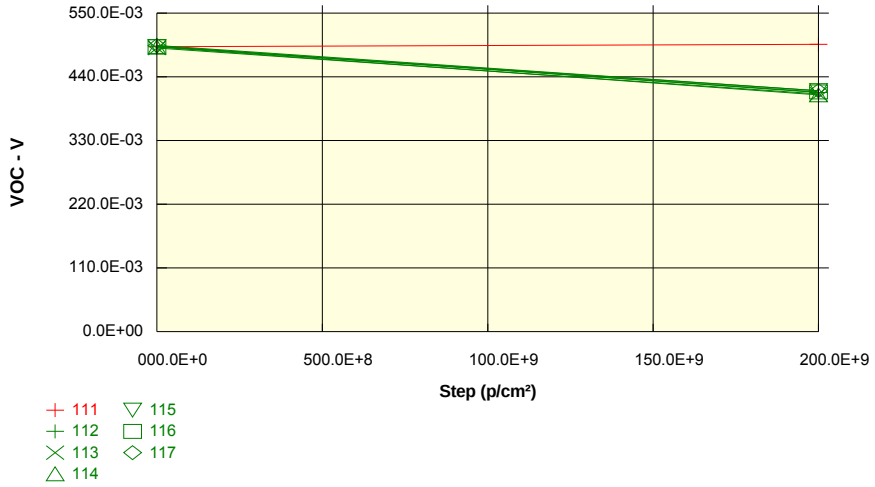
Measurements

VOCFB	0 p/cm²	2E+11 p/cm²
111_REF	489.2E-03	493.3E-03
OFF samples		
112	492.0E-03	411.3E-03
113	489.6E-03	409.9E-03
114	492.2E-03	409.3E-03
115	490.8E-03	415.1E-03
116	493.9E-03	416.0E-03
117	493.3E-03	415.2E-03
Statistics		
Min	489.6E-03	409.3E-03
Max	493.9E-03	416.0E-03
Average	491.9E-03	412.8E-03
Sigma	1.5E-03	2.7E-03

Drift Calculation

VOCFB	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-80.68E-03
113	-	-79.68E-03
114	-	-82.88E-03
115	-	-75.68E-03
116	-	-77.84E-03
117	-	-78.08E-03
Average	-	-79.14E-03
Sigma	-	2.29E-03

Test conditions : Protons
Parameter : Open Circuit Voltage : VOCFF
IF = 10 mA
Unit : V
No spec limit specified.



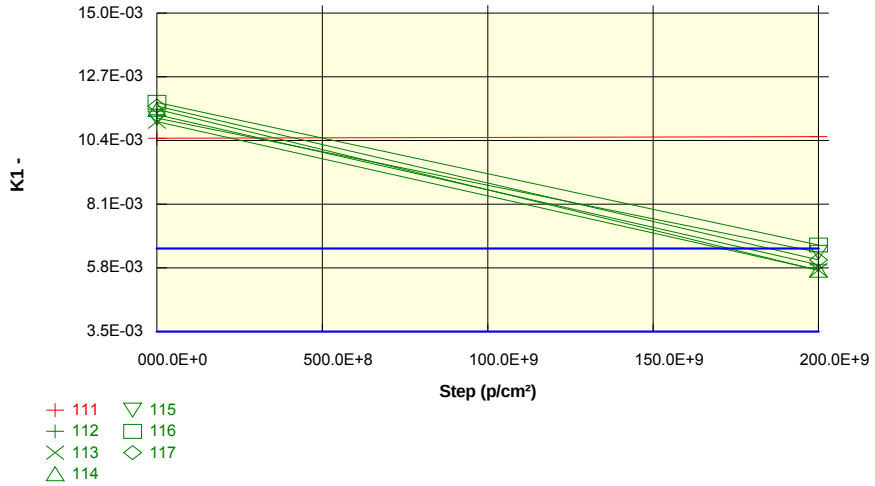
Measurements

VOCFF	0 p/cm²	2E+11 p/cm²
111_REF	491.9E-03	496.0E-03
OFF samples		
112	493.2E-03	412.9E-03
113	489.6E-03	410.4E-03
114	491.4E-03	408.7E-03
115	492.1E-03	415.9E-03
116	492.2E-03	413.9E-03
117	494.0E-03	416.2E-03
Statistics		
Min	489.6E-03	408.7E-03
Max	494.0E-03	416.2E-03
Average	492.1E-03	413.0E-03
Sigma	1.4E-03	2.7E-03

Drift Calculation

VOCFF	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-80.28E-03
113	-	-79.20E-03
114	-	-82.72E-03
115	-	-76.24E-03
116	-	-78.32E-03
117	-	-77.80E-03
Average	-	-79.09E-03
Sigma	-	2.04E-03

Test conditions : Protons
Parameter : Servo Current Gain (IP1/IF) : K1
IF = 10 mA. Vdet = -15 V
Unit :
Spec Limit Min : 3.5E-03
Spec Limit Max : 6.5E-03
Spec limits are represented in bold lines on the graphic.



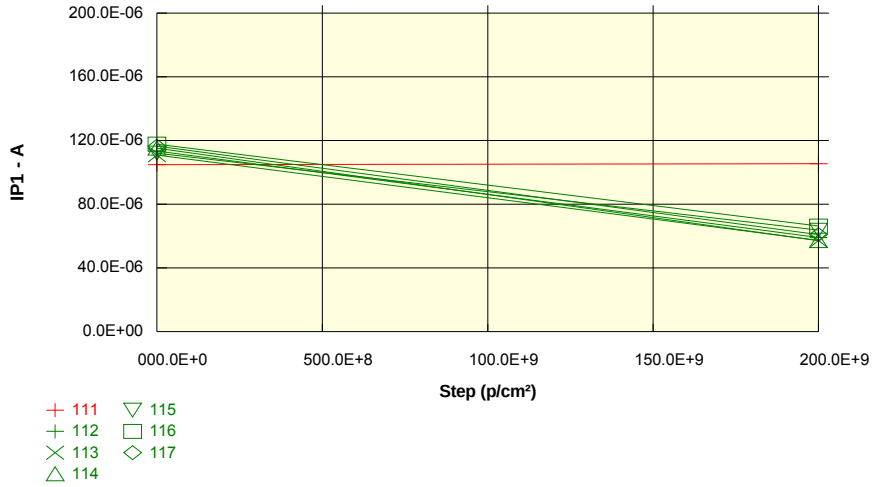
Measurements

K1	0 p/cm²	2E+11 p/cm²
111_REF	10.5E-03	10.5E-03
OFF samples		
112	11.3E-03	5.9E-03
113	11.1E-03	5.7E-03
114	11.5E-03	5.7E-03
115	11.2E-03	6.4E-03
116	11.8E-03	6.6E-03
117	11.6E-03	6.1E-03
Statistics		
Min	11.1E-03	5.7E-03
Max	11.8E-03	6.6E-03
Average	11.4E-03	6.1E-03
Sigma	243.0E-06	333.7E-06

Drift Calculation

K1	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-5.42E-03
113	-	-5.36E-03
114	-	-5.81E-03
115	-	-4.84E-03
116	-	-5.15E-03
117	-	-5.55E-03
Average	-	-5.35E-03
Sigma	-	303.70E-06

Test conditions : Protons
Parameter : Servo Current : IP1
IF = 10 mA. Vdet = -15 V
Unit : A
No spec limit specified.



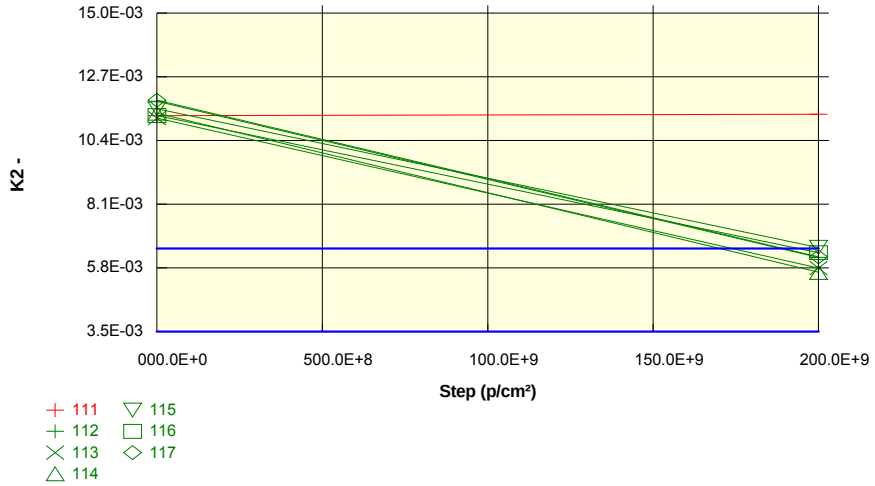
Measurements

IP1	0 p/cm²	2E+11 p/cm²
111_REF	104.8E-06	105.4E-06
OFF samples		
112	113.3E-06	59.1E-06
113	110.8E-06	57.2E-06
114	115.2E-06	57.1E-06
115	112.1E-06	63.6E-06
116	117.7E-06	66.3E-06
117	116.4E-06	60.9E-06
Statistics		
Min	110.8E-06	57.1E-06
Max	117.7E-06	66.3E-06
Average	114.3E-06	60.7E-06
Sigma	2.4E-06	3.3E-06

Drift Calculation

IP1	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-54.19E-06
113	-	-53.56E-06
114	-	-58.10E-06
115	-	-48.45E-06
116	-	-51.46E-06
117	-	-55.52E-06
Average	-	-53.55E-06
Sigma	-	3.04E-06

Test conditions : Protons
Parameter : Forward Current Gain (IP2/IF) : K2
IF = 10 mA. Vdet = -15 V
Unit :
Spec Limit Min : 3.5E-03
Spec Limit Max : 6.5E-03
Spec limits are represented in bold lines on the graphic.



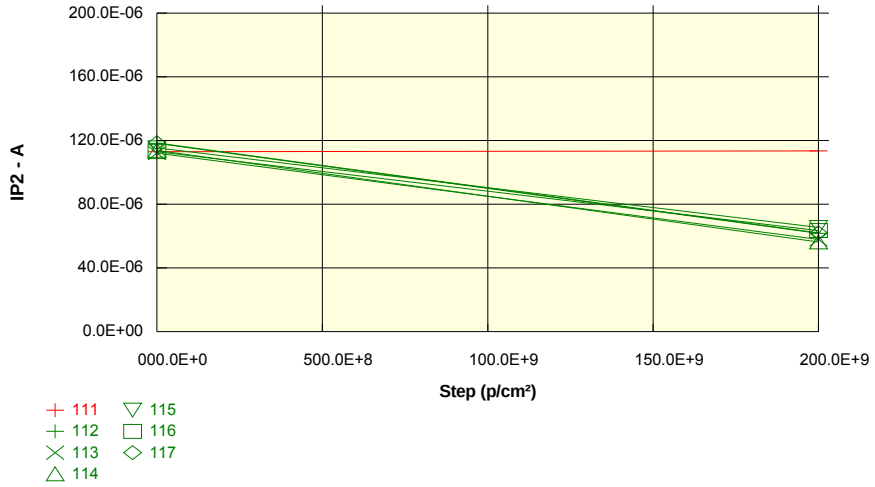
Measurements

K2	0 p/cm²	2E+11 p/cm²
111_REF	11.3E-03	11.3E-03
OFF samples		
112	11.8E-03	6.2E-03
113	11.2E-03	5.8E-03
114	11.4E-03	5.6E-03
115	11.5E-03	6.5E-03
116	11.3E-03	6.3E-03
117	11.9E-03	6.2E-03
Statistics		
Min	11.2E-03	5.6E-03
Max	11.9E-03	6.5E-03
Average	11.5E-03	6.1E-03
Sigma	244.6E-06	309.4E-06

Drift Calculation

K2	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-5.64E-03
113	-	-5.42E-03
114	-	-5.75E-03
115	-	-5.01E-03
116	-	-4.95E-03
117	-	-5.65E-03
Average	-	-5.40E-03
Sigma	-	313.89E-06

Test conditions : Protons
Parameter : Forward Current : IP2
IF = 10 mA. Vdet = -15 V
Unit : A
No spec limit specified.



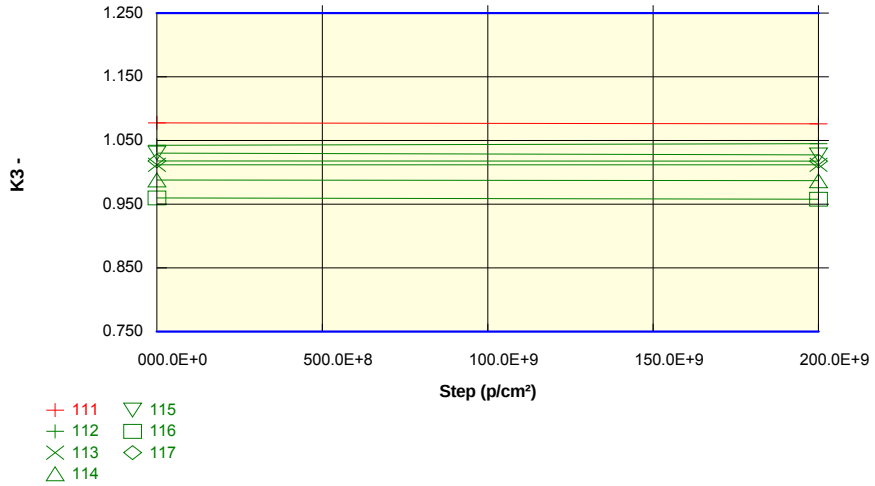
Measurements

IP2	0 p/cm²	2E+11 p/cm²
111_REF	113.0E-06	113.4E-06
OFF samples		
112	118.1E-06	61.8E-06
113	112.1E-06	57.9E-06
114	113.9E-06	56.4E-06
115	115.5E-06	65.4E-06
116	113.0E-06	63.5E-06
117	118.5E-06	62.0E-06
Statistics		
Min	112.1E-06	56.4E-06
Max	118.5E-06	65.4E-06
Average	115.2E-06	61.2E-06
Sigma	2.4E-06	3.1E-06

Drift Calculation

IP2	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	-56.35E-06
113	-	-54.18E-06
114	-	-57.47E-06
115	-	-50.09E-06
116	-	-49.55E-06
117	-	-56.52E-06
Average	-	-54.03E-06
Sigma	-	3.14E-06

Test conditions : Protons
Parameter : Transfer Gain (K2/K1) : K3
IF = 10 mA. Vdet = -15 V
Unit :
Spec Limit Min : 0.750
Spec Limit Max : 1.250
Spec limits are represented in bold lines on the graphic.



Measurements

K3	0 p/cm²	2E+11 p/cm²
111_REF	1.078	1.076
OFF samples		
112	1.043	1.045
113	1.012	1.012
114	0.988	0.987
115	1.030	1.027
116	0.960	0.958
117	1.018	1.018
Statistics		
Min	0.960	0.958
Max	1.043	1.045
Average	1.008	1.008
Sigma	0.027	0.028

Drift Calculation

K3	0 p/cm²	2E+11 p/cm²
OFF samples		
112	-	2.38E-03
113	-	146.03E-06
114	-	-1.22E-03
115	-	-2.81E-03
116	-	-2.22E-03
117	-	-267.62E-06
Average	-	-665.04E-06
Sigma	-	1.71E-03